City of Lincoln and County of Lancaster, NE

Geodatabase Knowledge Exchange

01/18/05

Agenda Overview

8:00 am	ESRI Arrive at Wastewater Facility and Set-up
8:30 am	Introductions and Meeting Goals
8:40 am	Discuss Data Migration Report Recommendations
9:45 am	Break
10:00 am	Geodatabase Concepts Discussion
Noon	Lunch
1:00 pm	Continue Geodatabase Concepts (if necessary) and Begin Geodatabase Modeling Exercise
2:45 pm	Break
3:00 pm	Complete Geodatabase Modeling Exercise
4:00 pm	Wrap-up

Goals

- Discuss Migration Plan
- Develop basic understanding of geodatabase and related topics
- Demonstrate geodatabase design process
- Showcase geodatabase features on sample data
- Look ahead to the migration

Migration Plan Overview

- Brief outline of the broad themes of the migration plan
- Discuss comments made regarding the migration plan
- Additional question and answer...

Migration Plan at a High-level

- City and County have a mature system primarily based on ESRI technology
- The current GIS is not-centralized and makes use of a mix of technology and data across the 17 organizations
- City and County both realize the need to migrate
  - Time to take advantage of newer paradigm: geodatabase and ArcGIS
- Looking for guidance on the appropriate steps to take in making the transition

What will it take to Migrate?

- Commitment from the members to make the move
- Devise a series of migration tracks (plan)
  - Workflow*
  - Data
  - Application
  - Organizational (Staff Training)
  - Hardware/Software
  - Coordination
- Identify who will champion the various tracks/tasks
- Prioritize tracks
- Decide where you need help
- Get to work

Comments and Question on the Migration Plan

- Where is workflow?
  - Workflow Analysis is necessary and is not addressed in detail in the document
  - Workflow should be the first task to be performed in the migration
  - Application, Data, HW/SW and Training are all dependent on workflow
  - The Honolulu Experience...

Comments and Question on the Migration Plan

- Contracting geodatabase and application migration
  - City and County comments reflect acknowledgement of this fact
  - ESRI would be available to
    1. Perform work where the City and County see fit
    2. Provide input into the search for known business partners who may also be able to provide assistance

Comments and Question on the Migration Plan

- Based on step-by-step documentation of several editing processes concern that some automated processes will now be manual
  - Some functionality that you now have automated could very well end up as manual processes in ArcGIS
  - ArcObjects, ModelBuilder, Scripting all provide ways of automating processes in ArcGIS
- Why change?
  - Core functionality, add on tools and the geodatabase will provide a more robust, integrated system (Share tools, geodatabase advantages, implement standard QC protocols, etc.)
  - ESRI feels that ArcGIS opens up GIS to many more people through the simpler UI

Comments and Question on the Migration Plan

- Coordinate Precision
  - Will 9.x improve on the 10 digits of coordinate precision?
    - Not at 9.0
    - In the future...there are rumors that ESRI development is discussing this very topic for future release of ArcGIS
  - How to handle double precision now?
    - Look at Survey Analyst model
    - Store x, y and z coordinates in attribute fields separate from Shape field

Geodatabase Concepts

- Topics
  - What is the geodatabase?
  - Types of Geodatabases
    - Personal
    - ArcSDE
  - Geodatabase Entities/Characteristics
    - Feature Classes, Object Classes and more…

What is the Geodatabase?

- ESRI Data Model
  - Container for spatial and attribute data
  - Builds off of and enhances existing data models
    - Stores simple and complex features
    - Allows grouping of features
    - Has built in attribute validation capabilities
    - Permits seamless data representation (no tiles)
  - Models feature behavior
    - Can more closely model real world behavior
    - Customize topological relationships between features
  - Scaleable (personal or ArcSDE geodatabases)

Types of Geodatabases

- Personal
  - Small, file based database
  - Built on MS Access
  - Supports up to 2GB of data*
  - Single user
  - Ideal for small environments or ‘one-off’ testing and/or projects

Types of Geodatabases

- ArcSDE
  - Large, enterprise GIS implementation
  - Built on RDBMS technology
    - Oracle, SQL Server, DB2 and Informix
  - No storage limits (based on RDBMS, not ArcSDE)
  - Multi-user through versioning and versioning workflows
  - Ideal for departmental and/or enterprise implementations

Geodatabase Entities

- Object Classes
  - Collection of attribute rows and columns
- Feature Classes
  - Collection of spatial features (shapefile)
- Feature Dataset
  - Collection of like feature classes (coverage)
- Topology
- Relationship Classes
- Raster Dataset
- Annotation
  - Feature Linked and Stand-Alone

Object Classes

- aka Tables
- Analogous to INFO tables (non-spatial)
- Can have behavior
  - Subtypes
  - Domains
  - Default Values

Feature Classes

- Analogous to shapefile data
- Stores geometry in SHAPE attribute
- Collection of features with the same
  - Geometry type
  - Attribution
  - Spatial reference
  - Behavior

Feature Dataset

- Analogous to a Coverage
- Collection of feature classes that have
  - The same spatial reference
  - Topological relationships
- Feature classes do not have to be the same geometry type
- Not a container for logical organization of data with like themes

Topology Classes

- Added to ArcGIS at the 8.3 release
- A feature that stores information on the topological associations between feature within one feature class or between separate feature classes with 26 rules (for now)
- Sits on-top of existing database design describing the interaction between features
    - Affects database design a great deal, not entities themselves
- Enforced during editing* and validation
- When designing a geodatabase, topological interaction between feature classes must be considered
- Users cannot edit errors in the topology unless they are addressed through the topology tools

*only when using the topology editing tools

Relationship Classes

- Persistent link between feature and object classes
- Stores:
  - Origin and destination tables
  - origin and foreign keys
  - Cardinality
- Differ from joins and relates in that they are not linked to an ArcMap document
- Traversed in ArcMap through the identify dialog

Raster Datasets

- Any valid raster format organized into bands
  - One (DEM with one value per cell) or more (color image with composite cell combinations)
- Supported in both ArcSDE and Personal* geodatabases
- Raster Catalog
  - Collection of raster datasets stored in table
  - Can store overlapping, different resolution images
  - Each record stores a raster dataset
  - Catalog (table) can be stored in geodatabase or in a file directory

*Rasters are not actually stored in personal geodatabases, but managed by ArcCatalog to appear as though they are in the geodatabase

Annotation Classes

- Database text analogous to coverage annotation
- Support Annotation Classes
  - Different types of anno can have different properties similar to coverage annotation classes (new at ArcGIS 9.0)
- Feature Linked
  - Related to a spatial feature class via relationship class
  - Dynamically updated
    - Annotation Value
    - Position
  - Can create from labels
- Stand Alone
  - Independent from other entities

Subtypes

- A way of classifying features to a smaller level of granularity within a feature class
- Applicable to features that…
  - Share Attribution Scheme
  - Share Geometry Type
  - Differ in their specific characteristics
- Designing features to use subtypes is preferable to designing multiple feature classes (performance)

Domains

- Valid value list similar to a look-up table
- Stored as a geodatabase property
- Applied to attribute columns
  - Can be applied to multiple fields
- Different subtypes can be assigned different domains
- Default domain values can be assigned
- Split/Merge Policies

Subtype\Domain Example

- Feature Class: Football Inventory
- * Subtype field
- ^ Domain applied (next slide)

League*	Brand^	Stripes	Kicker^	In Stock^
NCAA (d)	Nike	Half	N	Y
NFL	Wilson	None	Y	N
CFL	Spaulding	Complete	N	N

Domains Example

- Domain: Yes/No
  - Values: Y,N
- Domain: American Makers
  - Values: Nike*, Wilson, Bike
- Domain: Canadian Makers
  - Values: Spalding*, CCM, Bauer

ArcSDE and the Geodatabase

- What is ArcSDE?
  - ArcGIS's gate way to data stored in an RDBMS
  - Server based software
- What is an ArcSDE Geodatabase?
  - A remote geodatabase in an RDBMS served to client applications by ArcSDE
- ArcSDE Interaction with RDBMS...
  - *RDBMS* provides physical *storage* while ArcSDE interprets that data for use in GIS applications
  - Without the ArcSDE the raw data, particularly the geometry will not be interpreted by clients

Benefits of an ArcSDE Geodatabase

- Centralized spatial data storage
  - Large, non-tiles layers
  - Rapid spatial data searching
  - Store both vector and raster
- Concurrent access for a large number of users
  - Facilitated by versioning
- Leverages robustness of RDBMS
  - Security
  - Back-up and recovery
  - Scalability

ArcSDE Feature Classes

- Stored as one or more tables in RDBMS
  - To the user, a layer with millions of records, stored across several tables in RDBMS, is accessed logically as one entity Rapid spatial data searching
- Spatial column defines the geometry
- Tables that store entities features (spatial or non-spatial) are called business tables
- Each row in a business table represents a feature
  - One record for a simple four sided parcel or a complex shape with thousands of vertices

Accessing an ArcSDE Geodatabase

- ArcSDE workload is split between
  - RDBMS Server
  - ArcSDE Server
  - ArcSDE Client (I.E., ArcGIS)
- All queries to the RDBMS are made through SQL queries
  - SELECT, UPDATE, DELETE, etc.
- Clients generally process data
  - Display
  - Editing (before you save)
  - Analysis

Versioned Geodatabases

- Multiple, persistent representations of data
  - No need for data duplication
- Benefits of a versioned geodatabase
  - Simplifies the administrative process
  - Data centrally located
  - No data extraction
  - No data locking (Two people can edit the same feature)
- Personal geodatabases do not support versioning
  - File locking prevents multi-user access

Versioning

- What is a version?
  - A view of the database
- When a version is created, is my data duplicated?
  - No. A version stores the changes that have happened to the data since being ‘checked-out’
- Even though I have not checked out a version, is my database versioned?
  - Yes. Versioning is always ‘turned on’. An ArcSDE geodatabase always starts with one version (sde.default)
- Can I set permissions on individual versions?
  - Yes.

Versioning Cont'd

- Any table (spatial or non-spatial) can be multi-versioned
  - Multi-versioned tables may look different in different versions
  - Single versioned tables look the same in every version
- Tables must be 'Registered as Versioned' in order to create versions
- Registering a table as versioned creates delta tables
  - Adds
  - Deletes

Versioning Cont'd

- When editing in a version, all changes are written to the delta tables
  - Create features = Add
  - Delete feature = Delete
  - Update feature = Delete & Add
- Reconciling Versions..
  - Takes place in ArcMap during an edit session
  - Merges data from a target version to the current edit version

Versioning Cont'd

- Conflict Resolution
  - When reconciliation finds that two features have different representations, Conflict Dialog opens
  - Must choose which representation of the data should be used
- Posting changes
  - Takes place once reconciliation is complete between two versions
  - Writes changes to the target version.
  - Irreversible

Versioning Considerations

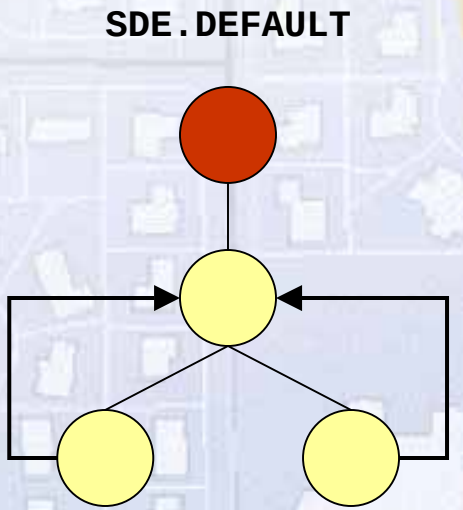
Workflow!!!!

- Maintain separate stages of a project
  - Unit of change represents different concepts
    - Integrated into business workflow
- Quality Assurance (QA)
  - Ensure timely and accurate database changes
  - Preserve geodatabase integrity
- Comply with procedures
- Maintain performance
- Security
  - Version permissions

Sample Version Workflow

Editing children of surrogate DEFAULT version

- Common ancestor version used as reconcile and post target
- Protects DEFAULT version
  - Prevents unauthorized/unintentional modifications
  - Reconcile and post to DEFAULT determined by workflow
- Establishes QA tier



Geodatabase Design

- Overview of process
- Different stages of a design
- Tools for creating a geodatabase design
- It's alive!!!
  - Once created, it will need some adjustments

Do I have to model my data?

- No, you don't have to perform a geodatabase design activity
- ArcGIS has tools that can be used to import existing data layers into the geodatabase without the need to design the features
- Without design, geodatabase functionality will not be automatically generated
- Creating a design prior to loading data is much easier than retro-fitting a poorly designed geodatabase with data loaded

Designing a Geodatabase

- Somewhere between art and science
  - No two organizations will have the same requirements
  - Use geodatabase principles and apply to unique situations
- Iterative process
  - New requirements or new ideas can affect model in progress
  - Some things work better than others and until you try it, you won't know

Geodatabase Design Process

1) Identify requirements of spatial data
   - Meet with various stake holders to assess their data needs
   - Examine existing data, application and workflow requirements
2) Look for commonalities with industry
   - Examine relevant, existing data models (ESRI has many)
3) Begin identifying and designing specific entities and features

Stages of Geodatabase Design

- Conceptual Design
  - Identify entities (layers)
  - Describe interactions between entities (tabular and spatial)
- Logical Design
  - Transform the conceptual design into geodatabase entities (feature classes, feature datasets etc.)
  - Done by modeling schema with attribution, subtypes, domains, relationship classes, etc.
- Physical Design
  - Apply logical design schema to an actual geodatabase design
  - ArcCatalog

Integrating Data Models

- ESRI has several data models that have been created for many of the various vertical markets
- In performing the database design all of the relevant models should be used at least as a starting point
- Customization will be required

Geodatabase Design Tools

- CASE Tools
  - MS Visio or Rational Rose
  - Diagram geodatabase design
  - Create schema as XML
  - Import XML into a geodatabase through ArcCatalog
- ArcCatalog
  - Convert logical design into a physical design using the ArcCatalog interface
  - Use properties dialogs to create and modify schema

Updating a Geodatabase Design

- The design will evolve
  - Through testing and even deployment updates to the design will be required
  - Application requirements, changes in ordinance, new technology and more...
- At some point it must be deployed
  - We can tweak and adjust a design endlessly
  - A point must be reached where all parties agree that we have modeled for as many of the requirements as possible

Geodatabase Exercise

- Purpose
  - Provide a better understanding of the geodatabase design process specific to a small sample of the City and County's data
- Method
  - Step through process undertaken to model landbase, cadastral and landuse sample in geodatabase
- Presentations and decisions were made independent of City and/or County
  - May not have accounted for the various intricacies that exist in this organizations

Conceptual Design

- Identify Entities
  - Look at existing data, documentation and user needs

Landuse (~~points and~~ polygon)
Zoning (~~points and~~ polygon)
Lots (~~point~~, ~~line and~~ polygon)
Parcels (~~point~~, ~~line and~~ polygon)
Condominium information (table)
Parcel Ownership (table)

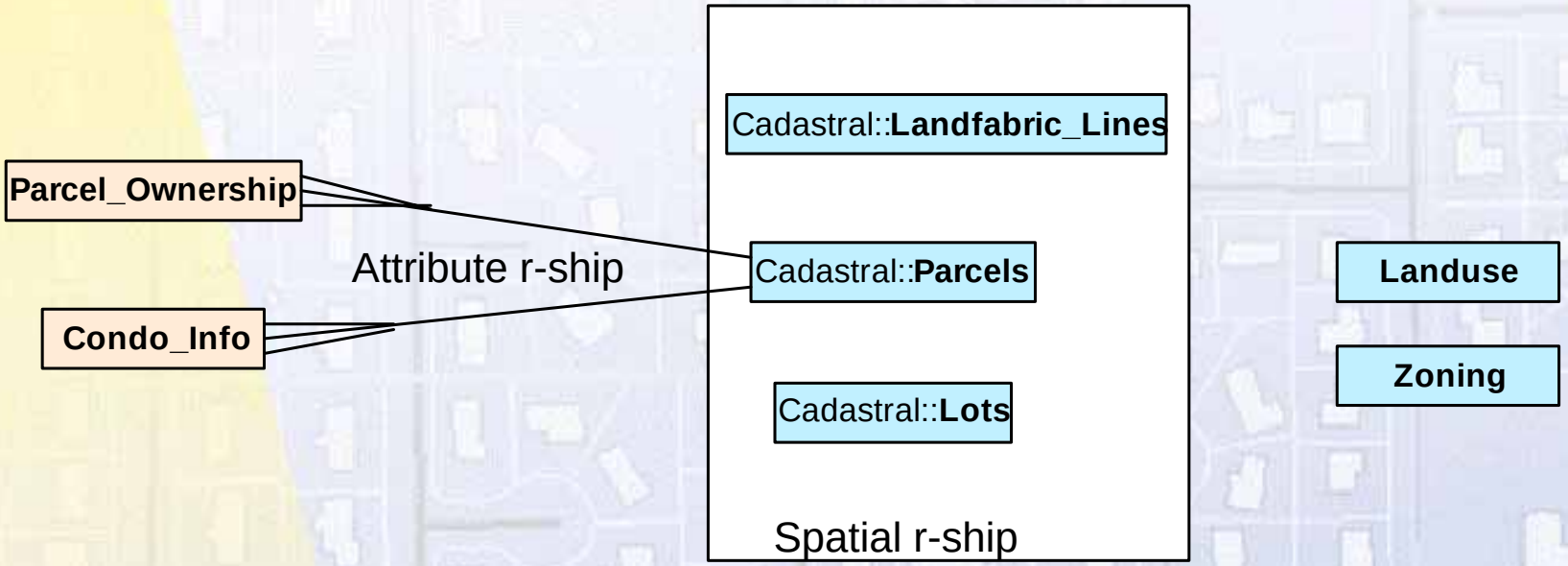
Landfabric_Lines

- Determine necessary feature types..

Conceptual Design

- Identify Relationships
  - How will these entities interact?
    - Parcels will have an attribute relationship to Condo info
    - Lots and parcels will share geometry (most of the time)
    - Parcel lines and parcel boundaries should always be the same (same with lots)
    - Parcels will have an attribute to Parcel Ownership

Conceptual Design



Logical Design

- Expand Conceptual Design to account for Geodatabase Features
  - Model attributes and definitions
  - Create Subtypes
  - Create Domains (Landuse codes and zoning classifications)
  - Create Relationships
- Using CASE tools allows you to simultaneously document the design and provides ability to reproduce geodatabase quickly
- Visio Geodatabase Design

Physical Geodatabase Design

- Convert the logical design into an actual geodatabase
  - Generate schema directly into ArcCatalog manually
  - Generate schema by importing from XML or repository created from CASE tools
- Manual creation of
  - Annotation
  - Topology
- Demonstrate creation of geodatabase

Data Migration Flow / Tools

- Prepare Source Data (if necessary)
  - Some manipulation of attribution may be necessary for example to accommodate new geodatabase design schema (Coverage Anno)
- Develop a migration matrix to keep track of
  - Layers to feature class
  - Source codes to subtypes
  - Attribution
- Load Data
- QC
- Tools
  - ArcGIS dialogs
  - Arc Toolbox Data loading/conversion tools
  - Custom models and scripts
  - Production Line Tool Set (PLTS)

Data Migration Issues

- Tiled data will need to be edgematched to remove any unnecessary tile boundaries
- Potential issues
  - Gaps
  - Overlaps
  - Unattributed features
  - Data scrubbing will be required
  - More

Create Topology

- Done in ArcCatalog within a feature dataset
- Define
  - Name
  - Cluster tolerance
  - Participating Layers
  - Ranking
  - Rules
- Create
- Validate

Topology Editing

- Editing a topology with…

1. Topology Editing Tools
   - Enforce topology rules on the fly as long as you use the topology select tools
2. Standard Editing Tools
   - Will allow you to perform edits that will cause errors in the topology
   - Will create ‘Dirty Areas’
   - Must validate topology to clear up topologies

Demonstrate

ArcGIS Toolbox

- Provides a variety of tools for use
  - Data Conversion
  - Data Management
  - Data Analysis
- Users can create custom tools
  - Scripts
  - Models
- Custom tools can be stored inside of a geodatabase
  - Frequently used tools can be disseminated with appropriate data

Moving forward….

- Business process/Workflow analysis and re-engineering should be tackled early in any migration
  - Defines application and data requirements

Table 6-1
Task Series and Tasks

Task Series 1:	**GIS Organization/Migration Scope Review**
Task 1.1:	Identify Potential GIS Organizational Modifications
Task 1.2:	Refine Migration Scope
Task Series 2:	**Prepare Geodatabase, Process and Application Design**
Task 2.1:	Refinement of GIS Data, Process and Application Requirements
Task 2.2:	Conceptual Database Design
Task 2.3:	Prepare Geodatabase Model
Task 2.4:	Review Geodatabase Model With Users
Task 2.5:	Refine Geodatabase Model
Task 2.6:	Conceptual Process and Application Design
Task Series 3:	**Geodatabase Pilot Project and Application Prototyping**
Task 3.1:	Select Pilot Area
Task 3.2:	Develop Procedures
Task 3.3:	Pilot Data Migration and Applications Prototyping
Task 3.4:	Pilot Evaluation
Task Series 4:	**Detailed Migration Planning**
Task 4.1:	Develop an ArcGIS Migration Action Plan
Task 4.2:	Define Data and Application Migration Priorities
Task 4.3:	Prepare Data and Application Migration Methodology
Task 4.4:	Prepare Data and Application Maintenance Procedures
Task 4.5:	Prepare Quality Assurance Procedures
Task Series 5:	**Conduct Staff Training**
Task 5.1:	Review Training Needs and Identify Training Participants
Task 5.2:	Conduct Training
Task Series 6:	**System Infrastructure Enhancements**
Task 6.1:	Refine Hardware, Software, and Networking Modifications
Task 6.2:	Prepare Budgetary Documents to Acquire Upgrades
Task 6.3:	Perform System Enhancements
Task Series 7:	**Perform Data and Application Migration**
Task 7.1:	Perform Data Migration Based on Data Priorities (Once complete, Data and Application Maintenance should begin)
Task 7.2:	Establish Appropriate Links to Oracle Databases
Task 7.3	Migrate Custom Applications
Task Series 8:	**Maintain Strategic Plan/Evaluate System Performance**
Task 8.1:	Evaluate Post migration Performance and Maintain Strategic Plan
Task 8.2:	Review Data and Application Requirements
Task 8.3:	Review System Infrastructure Requirements
Task 8.4:	Maintenance of Strategic Plan

Moving forward….

- Identify tasks that can be performed by the City and County
- Define project responsibilities (management and technical)
- Identify where assistance is needed

Questions/Comments